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**Conference Paper**

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56th Congress of the European Regional Science Association: "Cities & Regions: Smart, Sustainable, Inclusive?", 23-26 August 2016, Vienna, Austria

**Provided in Cooperation with:**

European Regional Science Association (ERSA)

*Suggested Citation:* Blien, Uwe; Dauth, Wolfgang (2016) : Job polarization on local labor markets?, 56th Congress of the European Regional Science Association: "Cities & Regions: Smart, Sustainable, Inclusive?", 23-26 August 2016, Vienna, Austria, European Regional Science Association (ERSA), Louvain-la-Neuve

This Version is available at:

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# Job Polarization on Local Labor Markets?

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Paper prepared for presentation at the Tasks IV Conference, Mannheim

29 July 2016

**JEL classification:** J31, J24, R23

**Keywords:** job polarization; local labor markets; job tasks; routine biased technological change; structural change

**Abstract:** In a number of industrialized countries employment has grown predominately in jobs at the upper and lower tails of the wage distribution, while employment in the middle of the distribution has stagnated or declined. According to Autor, Dorn (2013) among others, this phenomenon of polarization is related to routine-biased technological change. Jobs in the middle of the wage distribution involve a relatively large share of routine tasks that could be substituted by computer technology.

Our analysis is based on data from a new occupational classification and a new assessment concerning task contents. It is carried out for local labor markets in Germany. The analysis shows that the polarization hypothesis could be confirmed only weakly for this country: employment grows at the upper tail of the wage distribution, it shrinks in the middle and is constant at the lower tail of the distribution.

## 1. Introduction

The last couple of decades brought rapid changes to industrialized societies. Vast advances in technology changed the way how things are produced and how people interact with each other. While new technologies enhanced the productivity of workers in some jobs, other jobs were replaced by machines and became obsolete. There is a growing fear that this evolution polarizes entire societies.

In a number of industrialized countries employment has grown predominately in jobs at the upper and lower tails of the wage distribution, while employment in the middle of the distribution has stagnated or declined (see Autor, Dorn 2013, Goos, Manning, Salomons 2015). In this paper we are interested in assessing the situation in Germany. Though a number of papers (Senfleben, Wielandt 2014, Rendall, Weiss 2016) have already concentrated on this country, we think we can contribute to an assessment by exploiting an especially rich dataset with new classifications of occupations and tasks. In addition to the data aspect, we add a new theoretical perspective.

The term job polarization was popularized by Goos, Manning (2007). They build upon the hypothesis of Autor, Levy, Murnane (2003) that technological change is routine-biased, in other words that technological change is complementary to interactive tasks at the upper tail of the wage distribution and erodes demand for routine tasks in the middle, but is neutral to non-routine unskilled tasks, such as those in personal services. When occupations are ranked according to their initial average wage, jobs at both ends grow more strongly than those in the middle of the distribution. The result is the U-shaped wage/employment profile familiar from many recent studies.

Goos, Manning (2007) and Autor, Katz, Kearney (2006) find strong support for job polarization and its connection to routine-biased technological change (RBTC), both in the United Kingdom and the United States. Autor, Dorn (2013) derive an integrated model of how technological change leads to a decline in routine manual work but an increase in non-routine service occupations. Taking their model to US data on local labor markets, they find that regions with a high initial share of routine tasks are more inclined to adopt information technology and exhibit a relocation of routine workers to unskilled service jobs. Senfleben, Wielandt (2014) adopt this approach for Germany but corroborate the results only for female workers.

The bulk of the literature on the effects of technological progress on employment surprises by treating the general employment level as fixed. Influential theoretical models analyze equilibrium situations that exclude unemployment. The majority of empirical research concentrates on differential effects on occupations and skill groups and their employment development. This contrasts with popular publications that use recent assessments and forecasts prepared mainly outside mainstream economics (Brynjolfsson, McAfee 2011, 2014, Frey, Osborne 2013). In this context, severe em-

ployment losses are predicted as the consequence of recent technological developments. However, in the latter category of literature, interacting economic effects are not sufficiently integrated, and at least its popular reinterpretations follow the idea of ‘technological determinism’. Authors using this approach assume implicitly that the production of an economy is carried out in proportions that are technologically fixed. So if a task carried out by a productive worker is substituted by a machine, the consequence is that the worker is made redundant.

However, this substitution of workers by machines does not occur often. Autor (2015) provides an example (with reference to Bessen 2015): the number of automated teller machines (ATMs) in the US economy increased from about 100,000 (1995) to around 400,000 (2010). From the point of view of technological determinism the case is clear: human bank tellers can be expected to be made redundant due to the introduction of ATMs. In reality however, the number of human bank tellers increased from 500,000 to 550,000 between 1980 and 2010. On the one hand, this is due to a demand effect: a specific kind of technical progress, the introduction of ATMs, reduced the price of bank services, so demand for the services grew. On the other hand, the job description of bank tellers changed, too, now emphasizing the interaction with customers.

Another interesting example goes further back in history: the introduction of Henry Ford’s Model T. Table 1 below shows the price of the Model T and the sales figures following its market entry in 1908. Due to major technical innovations concerning mass production, especially the introduction of the assembly line, the price fell to about one third of its original price within only a few years. The last column of the table makes clear, that due to a productivity effect less workers were needed to produce a fixed number of cars. On the other hand, the sales figures exploded, and therefore Henry Ford’s factories employed far more workers in 1915 than in 1909.

As can be discussed on the basis of these examples, technological progress has two opposing effects on employment. The first one is a labor-saving effect, i.e. the direct substitution of labor by capital. According to technological determinism this is the only effect. The second effect, however, is a compensating one, which depends among other things on the price change generally triggered by technological progress. An increase in productivity leads to lower prices, to higher sales and to an additional demand for labor. Which effect dominates is an empirical question. The conclusion is that not even the direction of the employment effect can be directly attributed to the shock on productivity: this is the background of the criticism of technological determinism: technological progress might be disruptive and destructive, but it can also have welfare-increasing effects. The direction and strength of an employment effect

depend on shaping economic factors (there are also shaping institutional factors – but that is another story).

**Table 1: Prices and sold cars of Ford's Model T**

Year	Retail Price (\$)	Sales in thousands	No. of employees in thousands	Prod. cars per employee
1909	950	12	1.7	8.4
1910	780	19	2.8	7.5
1911	690	40	4.0	13.5
1912	600	79	6.9	12.0
1913	550	183	14.4	13.2
1914	490	261	12.9	17.9
1915	440	355	19.0	20.9
1916	360	577		

Source: Hounshell (1984: 224) for the first two columns and Beaudreau (2008: 71) for the last two columns

In this paper we intend to look at employment development on regional and occupational labour markets. We analyse whether there is a polarization pattern as it is in other countries. We relate the pattern to factors emphasised in the literature and look whether these can explain the occupational development, especially the share of routine tasks is included. In addition, we provide a brief overview of some of possible interacting processes, which can play a role for employment development, but are only briefly mentioned in the literature.

## Theory

In the following we intend to identify the economic conditions for the development of employment. It is easy to see that the price elasticity of demand on the respective product markets is an important factor. If prices fall as a consequence of productivity increases, it depends on the price elasticity of demand whether turnover rises or not. If demand is elastic (demand elasticity less than  $-1$ ), turnover increases, if it is inelastic (demand elasticity larger than  $-1$ ), then turnover decreases. Employment might develop in the same way as turnover.

Another factor influencing employment in the relevant economic sectors over longer spans of time is the income elasticity of the products concerned. If people increase their demand as their incomes rise this might also balance out possible negative

productivity effects. That is why Autor argues (2015: 7) that the interplay of these different elasticities on product markets dampens or amplifies the returns to technological progress. We would go one step further and argue that even the direction of the effect on the labor market depends on these elasticities.

It is possible to model the two factors to gain an intuition on how the balance between the labor saving and the compensation effect works. It is instructive to look at the simple macro-model developed by Appelbaum, Schettkat (e. g. 1999, which was used in empirical studies by Möller 2001 and Partridge et al. 2016). They show that the limiting value for the labor market effect is the direct price elasticity of demand plus one. Employment increases with productivity gains if product demand is elastic and it falls if product demand is inelastic. The model begins with a definition equation for the productivity of labor  $\pi$  in firm  $j$  in which the production quantity  $Q$  is related to the level of employment  $L$ .

$$\pi_j = \frac{Q_j}{L_j} \quad (1)$$

The second equation is a price-setting function based on a mark-up calculation. The price is  $P_j$ ,  $z$  is the mark-up factor, which also includes expenditures for capital and  $W_j$  is the wage rate.

$$P_j = \frac{z_j W_j}{\pi_j} \quad (2)$$

Finally, the third equation is a demand function, which falls with the price and rises with the national income  $y$ .

$$Q_j = f(P_j, y), \quad \text{with} \quad dQ_j/dP_j < 0, \quad dQ_j/dy > 0 \quad (3)$$

These equations in levels can be transformed into expressions of growth rates:

$$\hat{L}_j = \hat{Q}_j - \hat{\pi}_j \quad (1)'$$

$$\hat{P}_j = \hat{z}_j + \hat{W}_j - \hat{\pi}_j \quad (2)'$$

$$\hat{Q}_j = \eta \cdot \hat{y} + \varepsilon_j \cdot \hat{P}_j \quad (3)'$$

The definition of the price elasticity of demand is  $\varepsilon = \frac{P}{Q} \frac{dQ}{dP}$ , which implies that  $\varepsilon$  is expected to be negative. The definition of the price elasticity of demand includes a

sign transformation, but we avoid this step. If  $\hat{z} = 0$  from (1)' to (3)' the following expression for a firm's employment development is derived:

$$\hat{L}_j = \eta_j \hat{y} - (\varepsilon_j + 1) \hat{\pi}_j + \varepsilon_j \hat{W}_j \quad (4)$$

In (4) an expression is obtained that includes two elasticities, the income elasticity of demand  $\eta_j$  and the price elasticity  $\varepsilon_j$ . Therefore, the interplay of the elasticities, as Autor (2015) demanded, can be derived from the model from the model. However, it could be argued that it is only a macro-model whereas state-of-the-art economics would demand a micro-foundation. In fact this is also available. Blien, Ludewig (2016) develop a labor demand function from a Cobb-Douglas production function:

$$Q = AL^{1-\beta} K^\beta \quad \text{with } 0 < \beta < 1, K \text{ fixed} \quad (5)$$

Here,  $K$  represents capital and  $A$  is a technology parameter. The rather striking result Blien and Ludewig obtain for the dynamics of their model is shown in (6)

$$\hat{L} = -(\varepsilon + 1) \hat{A} - (\beta + (\beta - 1)\varepsilon) \hat{W} + \eta \hat{y} \quad (6)$$

The result is mainly equivalent to that of the macro-model. Other approaches also based on macro-models demonstrate the importance of the price elasticity of demand, namely Combes et al. (2004), Cingano, Schivardi (2004), and Blien, Sanner (2014). Blien, Ludewig (2016) additionally show that wages can be endogenized in their approach by introducing a wage curve. In this case, the reaction of employment to technological progress is dampened, but the turning point, the elasticity of minus one, is retained.

The conclusion from our discussion is that those parts of the labor market in which product demand is elastic will grow under the condition of technological progress. The parts that exhibit inelastic product demand will shrink under technological progress. Income elasticity is also important. Which occupations are affected and in which direction are empirical questions. Unfortunately, the elasticities of the relevant market segments are not known.

It is possible to estimate demand elasticities with data from official statistics, which are defined for single products or for single industries (see Blien, Ludewig 2016). At the moment there is no feasible way known to us, which allows the transfer of the results to occupations or tasks. Therefore, it remains an empirical question whether technological progress has favorable or unfavorable effects on unemployment. In the following, we intend to approach this question empirically.

## Data

The analysis of job polarization at the regional level requires comprehensive, detailed information about the labor force over a longer period of time. An ideal source of such

information is the complete register data of the German Federal Employment Agency (BA) which originate from the compulsory notifications made by employers to the social security insurance. Specifically, we use the so-called Employment History file (BeH) provided by the Institute for Employment Research (IAB). From the full sample of this dataset, a cross-section of all employees registered as employed on June 30 is drawn. These data cover all employees covered by social security, which accounts for about 80 percent of the German labor force (Dustmann, Ludsteck, Schoenberg 2008). The subset of economically active persons who are not included in this dataset comprises civil servants, the self-employed, and people who work for an income lower than a defined threshold (2010: € 400).

The data are very reliable, since they are used to calculate retirement pensions. The major caveat of the data is that wages are censored at the upper earnings limit for compulsory social security contributions (e.g. € 66,000 in western Germany, 2010). We use an imputation procedure suggested by Gartner 2005 to correct the top-coded values.

Since job polarization is a development over a longer period of time, we focus our analysis on western Germany, where data are available continuously from 1978 to 2010. The resulting dataset contains between 16,129,486 (1980) and 16,828,903 (2010) observations each year and provides information on daily wages (imputed), occupation, industry, qualification, place of work, as well as some social-demographic details. Information is available about whether a person works full-time, minor part-time (less than 18 hours) or major part-time (between 18 and 39 hours) but not about the exact working hours. We estimate full-time equivalents by weighting minor part-time with 16/39 and major part-time with 24/39, respectively.

We then aggregate our data to occupation/year or region/occupation/year cells. Our occupational classification consists of 67 items. While our data also provide occupational information at a much more detailed level, a high level of detail entails a risk of individual occupations not being separated in a meaningful way. Since we are ultimately interested in the relative growth and decline of occupations, it is important that this growth and decline occur for economic reasons and not as a result of arbitrary re-classifications. We thus use a functional aggregation provided by the research group “Occupational Labour Markets” at the Institute for Employment Research (Matthes 2016, forthcoming).

For each cell, we record the number of full-time equivalent workers, the median wage of male full-time workers and the shares of workers who have completed an apprenticeship or a university degree. The research group “Occupational Labour Markets” at the IAB also provides the task composition of each occupation from the BIBB/IAB Qualification and Career Survey, which collected information about the actual work of individual workers by asking questions about the tasks carried out (“Tätigkeitsschwerpunkte”, Stooß 1988).



Whereas in the past empirical research on production technology was carried out mainly in the form of case studies, on the basis of the BiBB-IAB surveys it is possible to assess technology effects with representative data. The production process is no longer a “black box” as it is in most collections of mass data, which are related only to market processes.

In a lengthy process (Matthes 2016, forthcoming) the information on tasks was made consistent over the single surveys and then transferred to the occupational units of the BEH we use. For each occupation, we thus have a time-varying measure of the percentage of non-routine analytical, interactive and manual as well as routine cognitive and manual tasks. However, for most of our analyses, we rely on the overall percentage of routine tasks.

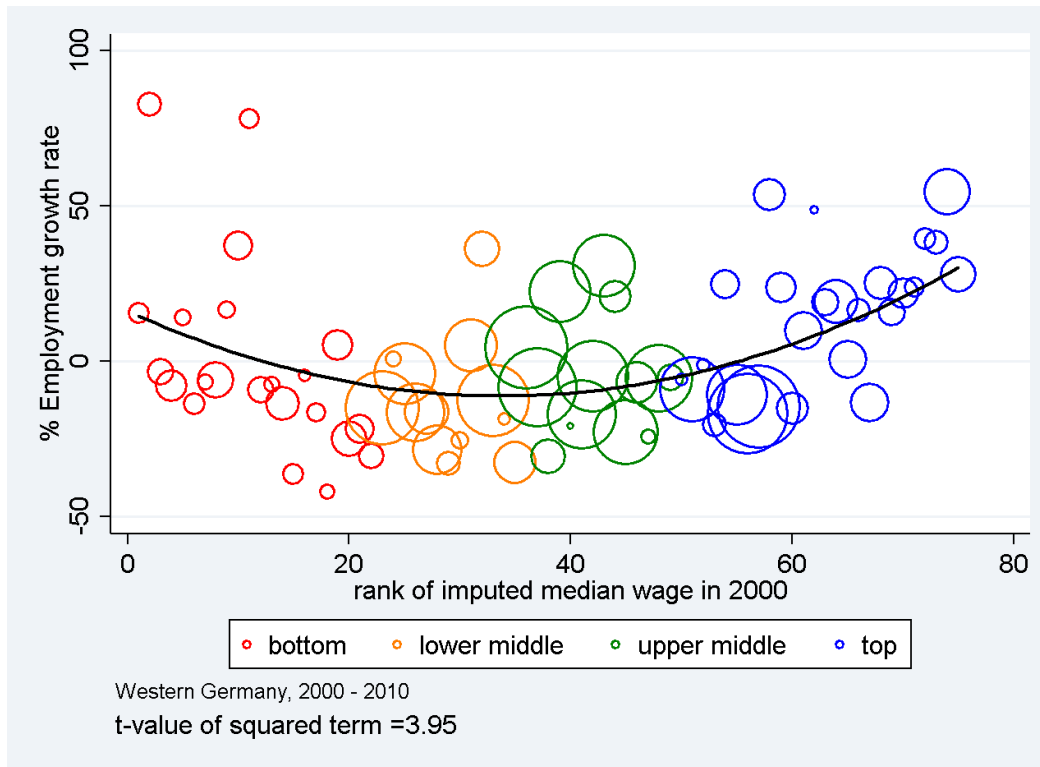
The level of regional aggregation are 204 regions. This classification bases on commuter flows between municipalities and can thus be regarded as a good approximation of functional labour markets. These regions are available from the Federal Institute for Research on Building, Urban Affairs and Spatial Development (BBSR) and will henceforth be called local labour markets (LLM)

## **Empirical Analysis**

Figure 1 presents the development of the 67 occupation groups over 10 years for the entire labor market of Western Germany. The size of the bubbles represents the number of people classified into these groups. In the horizontal axis the occupational groups are ordered according to their median daily wage of male full time workers at the beginning of the observation period (2000-2010). In the vertical axis the percentage growth or decline of employment is shown. The figure reveals that the German labor market is indeed characterized by a U-Curve during the first decade of the new century. For this time period the polarization hypothesis seems to be correct: High paying and low paying jobs develop well whereas the middle of the distribution is losing.

**Figure 1**

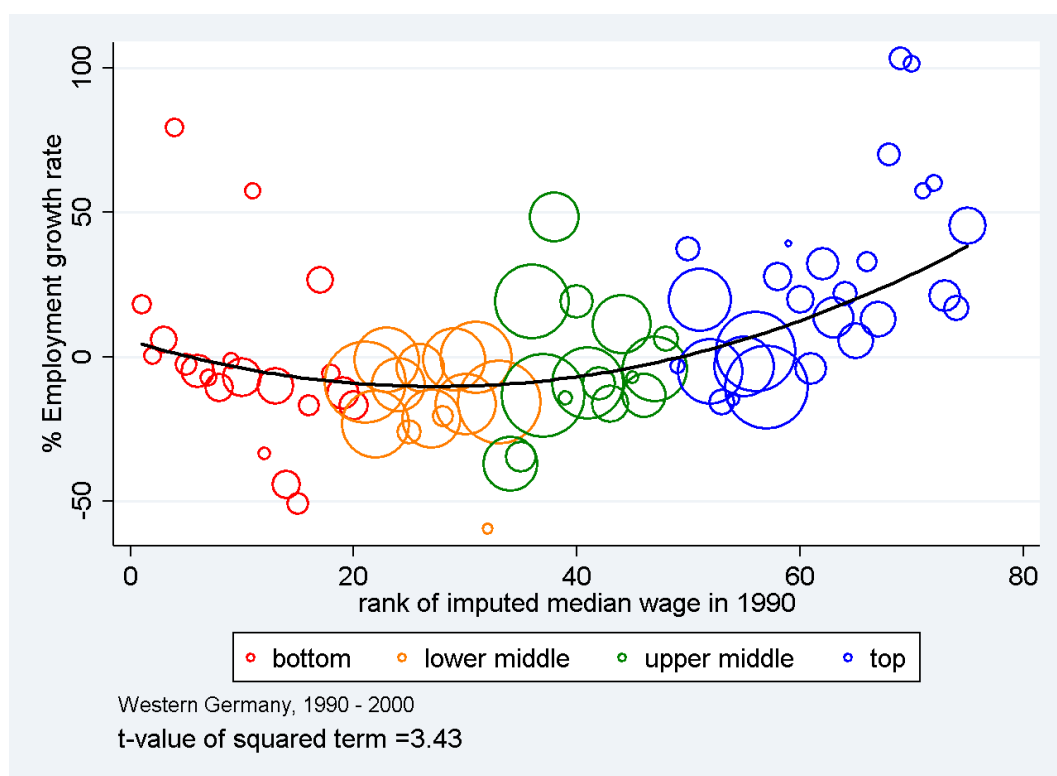
**Employment development with respect to occupational groups ordered by wage  
2000 - 2010**



The situation was different during the decade before as can be seen from Figure 2. For the nineties the regression function is more a “J-”, instead of a “U-Curve” as it was later for the German labor market and as it is for the labor market of the US.

Figure 3 shows the development in the eighties, which again was different: No polarisation pattern was visible. Instead, employment growth monotonously increased with the initial wage percentile. If the observation period includes all three decades, again the picture is the one of a J-Curve as is visible from Figure 4.

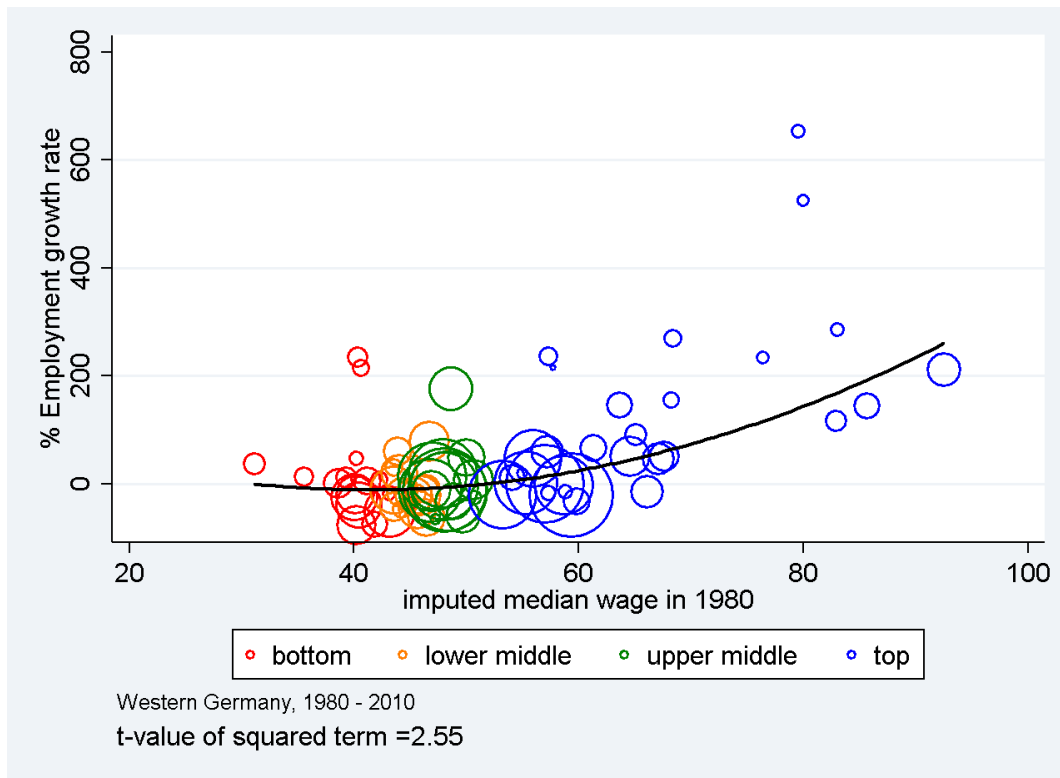
**Figure 2**  
**Employment development 1990-2000**



**Figure 3**  
**Employment development 1980-1990**



**Figure 4**  
**Employment development 1980-2010**



In order to check whether growth at both ends of the wage distribution really deviates from the middle part, we proceed with a regression analysis. Our unit of observation is the individual occupation within one labour market region. The response variable is the growth rate of this unit. For a descriptive assessment of the polarisation problem, we introduce three dummy variables, indicating a specific quartile of the distribution with respect to wages. These dummies are “bottom 25%”, “upper middle 25 %” and “top 25 %”. The remaining “lower middle 25%” is the reference category. At first, we use a pooled cross-sectional setting consisting of the three decades between 1980 and 2010. In one specific version we include fixed effects for Federal States. In the following tables, the coefficients of the models are presented with their standard errors in brackets. One star symbolizes 10 % significance, two stars 5 %, and three stars 1 %. We use clustered standard errors with respect to occupations.

Table 2 shows some descriptive results. All three models correspond to a J-curve or even to a degenerated J-curve. The dummy for the bottom end of the distribution is not significant, indicating that the lower two quartiles of the distribution show about the same growth rates. The upper two quarters grow faster than average. The highest figure is reached by the top quarter. The differences between the three models are small.

In the last model of Table 3 the logarithm of population density is also included as a right hand side variable in the regression equation. Its coefficient is negative and high-

ly significant. This is a little surprising since many approaches of regional economics expect that agglomerated areas show the highest economic activity. Cingano, Schivardi (2004) make clear that this could be the case with respect to productivity growth, which, however, might affect employment development negatively, if product demand is inelastic.

**Table 2: Panel with fixed effects for federal states (1980-2010)**

	b/se	state-FE b/se	state-FE b/se
log Pop. Density			-5.2720*** (0.776)
bottom 25%	0.4247 (2.781)	0.4285 (2.689)	0.4368 (2.648)
upper middle 25%	6.9357** (2.847)	6.9449** (2.785)	6.9528** (2.757)
top 25%	15.5056*** (4.417)	15.4947*** (4.378)	15.4997*** (4.382)
dummy, yr 1990=1	-10.7131*** (2.967)	-10.7131*** (2.974)	-10.5180*** (2.967)
dummy, yr 2000=1	-12.9753*** (4.753)	-12.9753*** (4.774)	-12.4424** (4.744)
Constant	4.1459 (5.246)	4.1456 (5.193)	34.2980*** (8.642)
N	45822	45822	45822
R <sup>2</sup>	0.074	0.080	0.089

In the next step we introduce some variables which might work as substitutes for the variables indicating the quartiles of the distribution. We do this again in a panel setting, which differ from the one presented in Table 2 by using a greater number of fixed effects. Now every labour market region is represented by a fixed effect, so that all coefficients are only identified across occupations within the same region and over time. The routine intensity of an occupation is included as a right hand side variable. It is defined as the degree to which a worker has to perform routine tasks in his or her work. In addition two variables are introduced which represent the share of workers with a vocational education and the share of those who have a university degree.

Table 3 shows the results. The coefficient of the routine intensity has the expected sign but is only weekly significant in a model which also includes the dummies for the quartiles of the distribution. The inclusion of the qualification variables reduces the significance levels of the quartile dummies and increases the R<sup>2</sup> of the models. In the German case technological progress seems to be associated with better qualified workers, whereas low and formally not qualified people are substituted by new technology.

**Table 3: Panel with fixed effects for regions (1980-2010)**

	LLM-FE b/se	LLM-FE b/se	LLM-FE b/se	LLM-FE b/se	LLM-FE b/se	LLM-FE b/se
bottom 25%	0.3349 (2.666)	0.5123 (3.024)	3.6892 (2.801)			
upper middle 25%	6.9119** (2.708)	7.0639*** (2.370)	4.8706** (2.130)			
top 25%	15.4310*** (4.305)	16.4588*** (3.694)	8.0415** (3.313)			
routine intensity		-0.2854* (0.162)	-0.1089 (0.162)	-0.2248 (0.217)		-0.0603 (0.158)
% voca. training			0.1039** (0.042)		0.1242*** (0.043)	0.1220*** (0.040)
% university degree			0.3920*** (0.086)		0.4676*** (0.066)	0.4587*** (0.069)
dummy, yr 1990=1	-10.7129*** (2.991)	-11.1262*** (2.905)	-12.1450*** (2.875)	-11.0378*** (3.027)	-12.2265*** (2.899)	-12.2858*** (2.896)
dummy, yr 2000=1	-12.9747*** (4.772)	-13.3308*** (4.771)	-15.1460*** (4.541)	-13.2243*** (4.887)	-15.3750*** (4.525)	-15.4044*** (4.538)
constant	4.1925 (5.106)	11.2525* (6.057)	1.0794 (6.685)	15.9394** (6.519)	0.9700 (4.741)	2.7008 (6.013)
N	45822	45822	45822	45822	45822	45822
R <sup>2</sup>	0.117	0.130	0.166	0.084	0.158	0.159

Tables 4 to 6 show separate analyses for single decades. Again, all specifications include fixed effects for local labor markets, so all coefficients are tightly identified across occupations within the same region. The results in the first three columns confirm the impression from the graphical evidence: jobs at the bottom of the wage distribution declined during the 1980ies, stagnated during the 1990ies and gained in employment during the 2000s. This pattern is apparently driven by differential demand for skills in those three decades. In the first two decades, employment predominately grew in (high) skill intensive occupations, whereas in the 1990ies, we even find a decline of occupations with a high share of workers with vocational training. As these are mainly found in the middle of the distribution, there is a negative correlation with the indicator variable for the bottom 25%, which drives the large positive coefficient of this indicator when skills are omitted from the model.

**Table 4: Time period of 1980 - 1990**

	LLM-FE b/se	LLM-FE b/se	LLM-FE b/se	LLM-FE b/se	LLM-FE b/se	LLM-FE b/se
bottom 25%	-10.4195*** (3.665)	-10.1854** (3.970)	1.6445 (3.109)			
upper middle 25%	8.3103* (4.280)	7.5594* (3.878)	-0.1697 (2.124)			
top 25%	17.1647*** (5.522)	18.4219*** (5.042)	-0.7060 (3.672)			
routine intensity		-0.3055 (0.258)	0.0477 (0.175)	-0.2469 (0.334)		0.0381 (0.165)
% voca. training			0.3912*** (0.035)		0.3800*** (0.035)	0.3817*** (0.033)
% university degree			0.7500*** (0.128)		0.7255*** (0.111)	0.7318*** (0.115)
constant	5.8739 (5.217)	13.6089* (7.492)	-17.9220*** (5.680)	16.5143* (8.585)	-15.7582*** (2.012)	-16.8718*** (5.162)
N	15257	15257	15257	15257	15257	15257
R <sup>2</sup>	0.158	0.173	0.402	0.072	0.402	0.402

**Table 5: Time period of 1990 - 2000**

	LLM-FE b/se	LLM-FE b/se	LLM-FE b/se	LLM-FE b/se	LLM-FE b/se	LLM-FE b/se
bottom 25%	2.1975 (3.035)	1.9618 (3.159)	2.9286 (3.599)			
upper middle 25%	7.3492** (3.396)	8.0168** (3.203)	7.0080** (2.961)			
top 25%	18.2193*** (4.643)	20.1206*** (4.080)	14.0919*** (4.086)			
routine intensity		-0.3422** (0.168)	-0.2229 (0.189)	-0.2284 (0.217)		-0.1106 (0.187)
% voca. training			0.0359 (0.049)		0.0789 (0.054)	0.0772 (0.050)
% university degree			0.3058*** (0.099)		0.4659*** (0.076)	0.4500*** (0.075)
constant	-7.8064** (3.510)	-0.0321 (4.377)	-5.1559 (6.192)	4.9891 (5.433)	-8.1167* (4.622)	-5.2122 (5.234)
N	15289	15289	15289	15289	15289	15289
R <sup>2</sup>	0.127	0.149	0.172	0.079	0.146	0.149

**Table 6: Time period of 2000 - 2010**

	LLM-FE b/se	LLM-FE b/se	LLM-FE b/se	LLM-FE b/se	LLM-FE b/se	LLM-FE b/se
bottom 25%	9.0035** (4.371)	9.3463** (4.652)	1.4593 (5.714)			
upper middle 25%	4.9346* (2.831)	5.3400* (2.718)	8.7884*** (2.830)			
top 25%	10.9220** (5.024)	11.1439** (4.752)	9.1321** (3.470)			
routine intensity		-0.1907 (0.217)	-0.2418 (0.234)	-0.1695 (0.220)		-0.1487 (0.248)
% vocc. training			-0.2013*** (0.068)		-0.1499** (0.059)	-0.1573*** (0.057)
% university degree			0.0894 (0.111)		0.2037** (0.083)	0.1826* (0.093)
constant	-9.1333*** (2.728)	-4.6592 (6.333)	11.5768 (9.998)	1.3476 (6.448)	6.2987 (5.497)	10.6229 (9.412)
N	15276	15276	15276	15276	15276	15276
R <sup>2</sup>	0.073	0.076	0.165	0.056	0.149	0.151

## Conclusion

The paper shows that for the German case with respect to employment development the polarization hypothesis is only confirmed weakly for this country: employment grows at the upper tail of the wage distribution, it shrinks in the middle and is constant at the lower tail of the distribution. At least this is true for the observation period of 1980 to 2010. For the recent decade of 2000, however, the polarization hypothesis is confirmed.

There is a common perception that demand for routine labor declined in the past decades. Our variable showed a coefficient with the expected sign, however, it was not significant. There are several explanations available for this fact. One was discussed in the theoretical part of the paper: Technological progress can have ambivalent effects on the occupations it affects.

Another possible explanation is suggested by the fact that the variables measuring higher qualification levels for an occupation indicate a favorable development. Technological progress might be complementary to occupations implying qualified work. Occupations requiring only low qualifications or no formal qualifications are those which are (partly) substituted.



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